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## OOGENESIS AND FERTILIZATION IN ALBUGO IPOMOEAE-PANDURANAE.

(WITH TWO FIGURES)

*Albugo Ipomoeae-panduranae* (Schw.) Swingle occurs upon various species of *Ipomoea*, among others the sweet potato, upon which it inflicts, however, but slight damage. Its most common host is probably *I. pandurata*, in which it induces great hypertrophy of leaves, stems, and flowers. The distortions are so marked as to attract the attention of even the casual observer. It is within these hypertrophied parts that the sexual organs and sexual spores are found in such abundance as to render this species the most favorable of all in the genus for the study of oogenesis and fertilization.

The material is killed in admirable condition if cut in pieces a few millimeters square (the outer part being first shaved off to avoid endangering the knife by adhering sand) and dropped in chrom-acetic acid of the strength recommended for other species of *Albugo*.<sup>1</sup> The stain chiefly employed is the triple stain of Flemming.

Inasmuch as several other species of *Albugo* have been described with considerable care, I will detail here only the more salient features, and those which present divergence from the usual types. The early history of oogenesis runs parallel with that of all other species of *Albugo* investigated; namely, the mycelium enlarges to form the oogonium, the nuclei enter, enlarge greatly, and pass to the spirem condition. This stage presents so little divergence from the same stage in other species that it is adequately represented by *fig. 45* drawn from *A. Bliti*.<sup>2</sup> Following the stage just described comes zonation or the differentiation of ooplasm from periplasm. In various species of *Albugo* zonation occurs in various ways. In *A. Bliti* the protoplasm condenses in masses which then run together to form the ooplasm.<sup>3</sup> In *A. Ipomoeae-panduranae* zonation partakes more of the character exhibited in *A. candida* and *A. Tragopogonis*, in which the protoplasm may be said to fall away from the oogonial wall, leaving behind only a few strands, sufficient to suspend the oosphere in the center. This type of zonation is sufficiently illustrated by *fig. 27* drawn from *A. Tragopogonis*.<sup>4</sup>

<sup>1</sup> STEVENS, F. L., The compound oosphere of *Albugo Bliti*. BOT. GAZ. 28:149-176, 225-245. pls. 11-15. 1899. (p. 233).

<sup>2</sup> STEVENS, F. L., *loc. cit.*, pl. 12.      <sup>3</sup> STEVENS, F. L., *loc. cit.*, pl. 13, figs. 60-65.

<sup>4</sup> STEVENS, F. L., Gametogenesis and fertilization in *Albugo*. BOT. GAZ. 32:77-98, 157-169, 238-261. pls. 1-4. 1901. (pl. 3).

With the inception of zonation comes the advance from the spirem to the later stages of mitotic division in all the nuclei of the oogonium. Many of the nuclei in process of division are floated to the periplasm, others complete the division within the ooplasm and there leave both daughter nuclei within the egg. The completion of this mitosis results in conditions very like those in *A. Tragopogonis*.<sup>5</sup> Many of the nuclei are in the periplasm, some are in the ooplasm. The chief difference lies in the coenocentrum, to be discussed later.

The daughter nuclei of the first division, which remain within the ooplasm, proceed to a second mitosis as in *A. Tragopogonis* and *A. candida*, though the number of oospheric nuclei is constantly diminishing, owing to their outward movement. All of them, except one or two contiguous to the coenocentrum, reach the periplasm before or immediately after mitosis is completed. One or two nuclei in mitosis are seen attached to the coenocentrum during the second division. The completion of the mitosis, however, finds only one daughter nucleus remaining thus to function as the female pronucleus. Conclusive evidence was not obtained, but it is probable that some nuclei suffer degeneration within the ooplasm, as is the rule in *A. Tragopogonis*.

The coenocentrum is first to be seen as a homogeneous globule, much like the central globule of *A. Bliti*, though considerably larger, being nearly as large as the nuclei at the completion of the first mitosis. There is no striking differentiation of the protoplasm surrounding the globule at this time. The globule, which does not change materially in size in later periods, is larger than that of *A. Bliti* and much smaller than that of *A. candida*, and it shows much less structural differentiation than is exhibited by the globule in the latter species. When the second mitosis approaches metaphase the globule is surrounded by zones of protoplasm of varying density. In character these resemble the structure shown in *figs. 69* and *71* drawn from *A. Bliti*,<sup>6</sup> though the development attains a higher degree in *A. Ipomoeae-panduranae*.

The attractive power of the coenocentrum for nuclei is evidenced by the attachment of one or more nuclei to it before and during the second mitosis (*figs. 1, 2*), a phenomenon precisely like that already described for *A. Tragopogonis* and *A. candida*. After the completion of the second division the coenocentrum degenerates.

The antheridial tube, shorter in this than in most species of *Albugo*, opens at about the time of the completion of the second division, emptying

<sup>5</sup> STEVENS, F. L., *loc. cit.*, *pl. 3, fig. 31*.

<sup>6</sup> STEVENS, F. L., The compound oosphere of *Albugo Bliti*. *loc. cit. pl. 13*.

one male nucleus into the ooplasm. This nucleus joins the female, and each enlarges much before pronuclear union, which is completed in the ruins of the decadent coenocentrum.

Simultaneous with the opening of the antheridial tube begins the construction of the oospore walls. These are completed much as in other species of *Albugo*, with the exception that there is a slight though very perceptible thickening of the oogonial wall itself. Such thickening is one of the chief features in the spore of *Sclerospora*, but is not known to occur in any other species of *Albugo*.

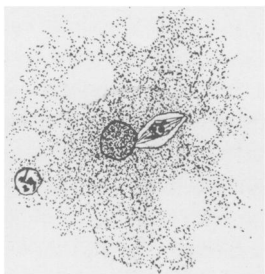


FIG. 1.

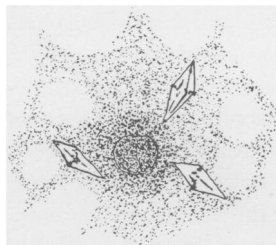


FIG. 2.

FIG. 1.—Central globule and coenocentrum of *A. Ipomoeae-panduranae* during second mitosis; one nucleus attached.

FIG. 2.—Similar to *fig. 1*; nuclei not yet attached to the coenocentrum.

Subsequent to fertilization, which does not proceed with that extreme slowness noted in some species, the fusion nucleus divides mitotically, increasing the number of nuclei before the assumption of the resting stage.

A minor point, worthy of mention as an indication of chemical composition, is a feature of the staining, conspicuous in this species but not known in any other *Albugo*. All of that portion of the fertilizing tube which touches the periplasm, and often the whole antheridium as well, takes the gentian-violet with great avidity and retains it longer than do any other structures. Antheridia and antheridial tubes are thus rendered remarkably conspicuous, and dozens are often seen in a single field with the two-thirds objective.—F. L. STEVENS, *A. and M. College, West Raleigh, N. C.*